

Claims

- [c1] 1.A method of making an inductive coupler for downhole components, comprising the steps of:
providing an annular housing having a recess; a conductor; and a plurality of generally U-shaped MCEI segments;
forming an assembly by placing the plurality of MCEI segments within the recess in the annular housing, wherein said segments are aligned to form a generally circular trough and placing a first portion of the conductor within the circular trough;
consolidating the assembly with a meltable polymer to thereby fill spaces between the segments, annular housing and the first portion of the conductor.
- [c2] 2.The method of claim 1 wherein the annular housing defines an opening therethrough which communicates with the recess, and wherein a second portion of the conductor passes through the opening.
- [c3] 3.The method of claim 1 wherein the annular housing is electrically conducting.
- [c4] 4. The method of claim 3 wherein an end of the conduc-

tor is electrically connected to the annular housing.

- [c5] 5.The method of claim 4 wherein an end of the first portion of the conductor is attached to the annular housing by welding.
- [c6] 6.The method of claim 4 wherein an end of the first portion of the conductor is attached to the annular housing by brazing.
- [c7] 7.The method of claim 1 wherein the assembly further comprises a meltable polymer liner located in the recess, and wherein the assembly is consolidated by applying sufficient heat to at least partially melt the liner.
- [c8] 8.The method of claim 7 wherein the annular housing defines an opening therethrough which communicates with the recess, wherein a second portion of the conductor passes through the opening, wherein the segments are arranged so as to provide a gap therebetween adjacent the opening; and wherein the liner is likewise arranged so as to provide a gap adjacent the opening.
- [c9] 9.The method of claim 7 wherein the liner comprises a fluoropolymer.
- [c10] 10.The method of claim 9 wherein the fluoropolymer is chosen from the group consisting of PFA, FEP, ETFE, AF,

PTFE, and ECTFE.

- [c11] 11.The method of claim 1 wherein the assembly further comprises a generally circular, meltable polymer cap located adjacent the circular trough formed by the plurality of MCEI segments, and wherein the assembly is consolidated by applying sufficient heat to at least partially melt the cap.
- [c12] 12.The method of claim 1 wherein the cap includes a protrusion that fits within the trough.
- [c13] 13.The method of claim 11 wherein the meltable cap comprises a fluoropolymer.
- [c14] 14.The method of claim 13 wherein the fluoropolymer is chosen from the group consisting of PFA, FEP, ETFE, AF, PTFE, and ECTFE.
- [c15] 15.The method of claim 1 wherein the consolidating step comprises infusing a meltable polymer from outside the assembly.
- [c16] 16.The method of claim 15 wherein the meltable polymer comprises a fluoropolymer selected from the group consisting of PFA, FEP, ETFE, AF, PTFE, and ECTFE.
- [c17] 17.The method of claim 1 wherein the meltable polymer is raised to a temperature between the range of about

250 °C and 450 °C during the consolidating step.

- [c18] 18.The method of claim 17 wherein the temperature is about 330 °C.
- [c19] 19.The method of claim 1 wherein pressure is applied to the assembly during the consolidating step.
- [c20] 20.The method of claim 19 wherein the pressure is between about 20 psi and about 150 psi.
- [c21] 21.The method of claim 20 wherein the pressure is about 100 psi.
- [c22] 22.The method of claim 1 wherein the MCEI segments comprise ferrite.
- [c23] 23.The method of claim 1 wherein the conductor comprises a material selected from the group consisting of copper, copper clad steel, silver plated copper clad steel, nickel plated copper clad steel, copper clad stainless steel, silver plated copper clad stainless steel, and nickel plated copper clad stainless steel.
- [c24] 24.The method of claim 1 wherein the conductor is an insulated wire.
- [c25] 25.A method of making an inductive coupler for down-hole components, comprising the steps of:

providing an annular housing having a recess, an insulated wire, a plurality of generally U-shaped MCEI segments, a meltable polymer liner and a circular, meltable polymer cap;
forming an assembly by
placing the liner within the recess,
placing the plurality of MCEI segments on top of the liner, wherein said segments are aligned to form a circular trough,
placing a first portion of the insulated wire within the circular trough, and
placing the cap on top of the MCEI segments; and
consolidating the assembly by applying sufficient heat to at least partially melt the liner and the cap, to thereby fill spaces between the segments, annular housing and the first portion of the insulated wire.

[c26] 26.The method of claim 24 wherein the insulating material of the insulated wire is bonded to the wire.

[c27] 27.The method of claim 26 wherein the wire is insulated with a thermoplastic polymer.

[c28] 28.The method of claim 27 wherein the thermoplastic polymer is a fluoropolymer.

[c29] 29.The method of claim 28 wherein the fluoropolymer is

chosen from the group consisting of PFA, FEP, ETFE, AF, PTFE, and ECTFE.

[c30] 30. An inductive coupler for downhole components, comprising:

an annular housing having a recess defined by a bottom portion and two opposing side wall portions, at least one of the two side wall portions comprising a lip extending toward, but not reaching the other side wall portion;

a plurality of generally U-shaped MCEI segments disposed within the annular housing to form a generally circular trough;

a conductor disposed within the trough;

a polymer filling spaces within the recess and between the MCEI elements and the conductor, and such that the lip functions to retain the MCEI elements within the recess.

[c31] 31. The inductive coupler of claim 30 wherein the segments comprise a bottom portion and two opposing side portions, which portions together form a trough, and wherein at least one of the side portions includes at least one groove in its surface opposite said trough.

[c32] 32. The inductive coupler of claim 31 wherein the MCEI segments are aligned in the recess to form a gap between the segments and the lip.

- [c33] 33.The inductive coupler of claim 32 wherein a pocket formed between the groove and the annular housing is wider than the gap.
- [c34] 34.The inductive coupler of claim 31 wherein each of the two opposing side portions comprise an overhang extending toward but not reaching the other side portion.
- [c35] 35.The inductive coupler of claim 30, wherein the polymer is thermoplastic.
- [c36] 36.The inductive coupler of claim 30, wherein the polymer is a fluoropolymer.
- [c37] 37.The inductive coupler of claim 36, wherein the fluoropolymer is chosen from the group consisting of PFA, FEP, ETFE, AF, PTFE, and ECTFE.
- [c38] 38.The inductive coupler of claim 30 wherein the polymer adheres to the annular housing.
- [c39] 39.The inductive coupler of claim 30, wherein the polymer adheres to the conductor.
- [c40] 40.The inductive coupler of claim 30, wherein the polymer does not adhere to the MCEI segments.
- [c41] 41.The inductive coupler of claim 30 wherein the trough has an opening that is narrower than the diameter of the

conductor.

- [c42] 42.The inductive coupler of claim 30 wherein the conductor comprises a material selected from the group consisting of copper, copper clad steel, silver plated copper clad steel, nickel plated copper clad steel, copper clad stainless steel, silver plated copper clad stainless steel, and nickel plated copper clad stainless steel.
- [c43] 43.The inductive coupler of claim 30 wherein the conductor is wire insulated with an insulating polymer.
- [c44] 44.The inductive coupler of claim 43 wherein the insulating polymer is bonded to the wire.
- [c45] 45.The inductive coupler of claim 43 wherein the insulating polymer is thermoplastic.
- [c46] 46.The inductive coupler of claim 45, wherein the insulating polymer is a fluoropolymer.
- [c47] 47.The inductive coupler of claim 46 wherein the fluoropolymer is chosen from the group consisting of PFA, FEP, ETFE, AF, PTFE, and ECTFE.
- [c48] 48.The inductive coupler of claim 30 wherein the MCEI segments include a plurality of grooves on its outer surface.

- [c49] 49.The inductive coupler of claim 48 wherein the plurality of grooves act as barbs to retain the segments within the annular housing.
- [c50] 50.The inductive coupler of claim 30 wherein the MCEI segments comprise ferrite.
- [c51] 51.The inductive coupler of claim 30 wherein the annular housing is made of metal selected from the group consisting of steel, titanium, chrome, nickel, aluminum, iron, copper, tin, and lead, as well as alloys thereof.
- [c52] 52.The inductive coupler of claim 30 wherein the annular housing is made of a steel selected from the group consisting of viscount 44, D2, stainless steel, tool steel, and 4100 series steels.
- [c53] 53.The inductive coupler of claim 30 wherein an end of the conductor is electrically connected to the annular housing.
- [c54] 54.The inductive coupler of claim 53 wherein an end of the first portion of the conductor is attached to the annular housing by welding.
- [c55] 55.The inductive coupler of claim 53 wherein an end of the first portion of the conductor is attached to the annular housing by brazing.

